Well-to-Wheels Results of Energy Use, Greenhouse Gas Emissions, and Criteria Air Pollutant Emissions of Selected Vehicle/Fuel Systems

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ABSTRACT

A fuel-cycle model—called the *G*reenhouse gases, *R*egulated *E*missions, and *E*nergy use in *T*ransportation (GREET) model—has been developed at Argonne National Laboratory to evaluate well-to-wheels (WTW) energy and emission impacts of motor vehicle technologies fueled with various transportation fuels. The new GREET version has up-to-date information regarding energy use and emissions for fuel production activities and vehicle operations. In this study, a complete WTW evaluation targeting energy use, greenhouse gases (CO_2, CH_4, and N_2O), and typical criteria air pollutants (VOC, NO_X, and PM_{10}) includes the following fuel options—gasoline, diesel, and hydrogen; and the following vehicle technologies—spark-ignition engines with or without hybrid configurations, compression-ignition engines with hybrid configurations, and hydrogen fuel cells with hybrid configurations. Because the parametric assumptions in the GREET model involve uncertainties, we conducted stochastic simulations with GREET by establishing probability distribution functions for key input parameters (e.g., energy efficiencies, emission factors) regarding well-to-pump (WTP) activities and vehicle operations based on the detailed up-to-date data. We applied the Hammersley Sequence Sampling (HSS) technique for stochastic simulations in GREET to take into account the probability distributions of key input parameters, and produced the results in the form of a statistical distribution for a given energy or emission item. The WTW analysis shows that advanced vehicle/fuel systems achieve reductions in energy use, greenhouse gas emissions, and criteria pollutant emissions compared to baseline gasoline vehicles through 1) improved vehicle fuel economy, 2) reduced tailpipe/evaporative vehicle emissions, and/or 3) differences in fuel production pathways.